Small Spacecraft Technology

NASA

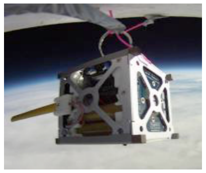
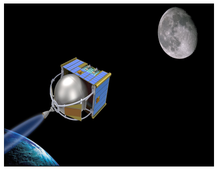
NASA Town Hall Meeting

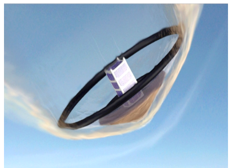
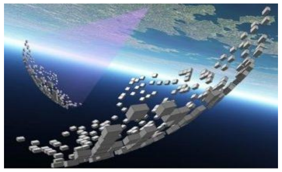
2012 Small Satellite Conference
Utah State University

August 13, 2012

Goals for NASA Small Spacecraft Technology Program

- **Advance the capabilities of small spacecraft to support NASA missions in science, exploration and space operations**
  - **Develop the unique capacities of small spacecraft to perform missions or examine phenomena not possible otherwise**
  - **Unleash NASA's unique capabilities and assets into the already vibrant small spacecraft community**
- **Foster the growth of the "small spacecraft philosophy" across broader NASA and space industry activities**
  - **rapid, agile and aggressive technology development**
  - **smaller scale, lower cost and shorter schedules**
  - **higher risk tolerance with higher potential payoff**
  - **faster transition from laboratory to flight demonstration**
  - **stronger workforce with early and frequent flight project experience**
  - **introduce components and techniques from non-traditional sources**

Organization

- **NASA Space Technology Program**
  - Centennial Challenges
  - NIAC
  - Space Technology Research Grants
  - Center Innovation Fund
  - SBIR &STTR
  - Game Changing Technology
  - Small Spacecraft Technology
  - Technology Demonstration Missions
  - Flight Opportunities

Organization

Franklin Small Satellite Subsystem Technologies + Edison Small Satellite Demonstration Missions = **Small Spacecraft Technology Program**

Technology Research and Development

- **Maturing technologies from TRL ~ 3 to 5**

Flight Demonstrations

- **Maturing technologies & mission capabilities from TRL ~5 to 7+**

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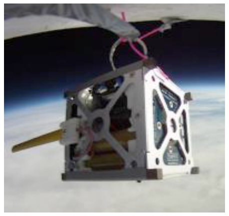
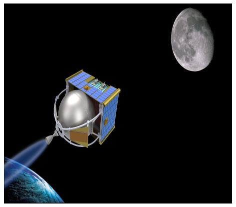
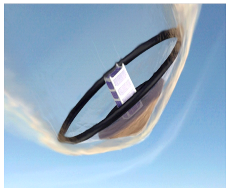
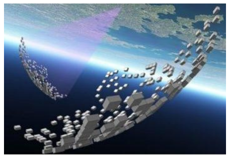
Current Activities

- PhoneSat 1.0 & 2.0 *NASA ARC*
- Edison Demonstration of Smallsat Networks (EDSN)
  NASA ARC with MSFC
- New Projects
  - Integrated Solar Array and Reflectarray
    Richard Hodges - JPL
  - Optical Communications and Proximity Sensors
    Siegfried Janson – Aerospace Corp
  - Proximity Operations Demonstration
    Charles MacGillivray – Tyvak
- Investment Strategy Development
- New Solicitations and Projects
  Technology Developments and Flight Demonstrations
- Other Initiatives

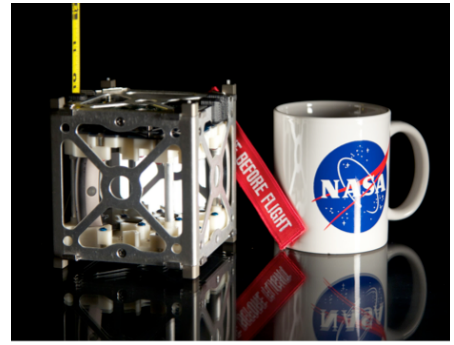







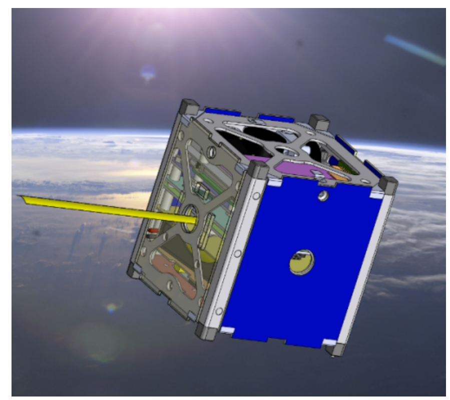
PhoneSat 1.0/2.0b Mission

Two PhoneSat-1.0 units to demonstrate use of Nexus S smart phone the flight avionics for a small satellite (1-U CubeSat)



One PhoneSat-2.0 unit to demonstrate Nexus S smartphone as the flight avionics, a low cost reaction wheel-based attitude control system, and solar cell power.

All 3 spacecraft have corner reflectors to assess laser comm potential for cubesats.



- Launch: Orbital Science Antares – October 2012
  Wallops Island, VA

•Orbit: 250km circular, 51 deg inclination

•Mass: 1.2 kg

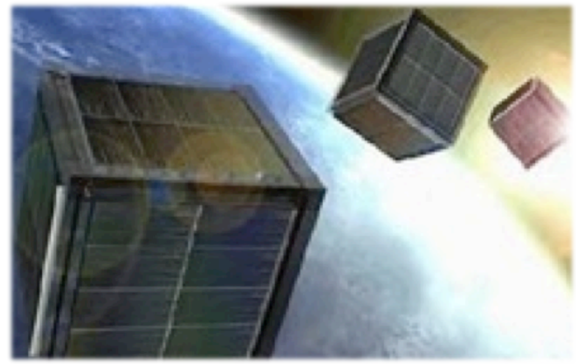
•Size: 10cm x 10cm x 10cm

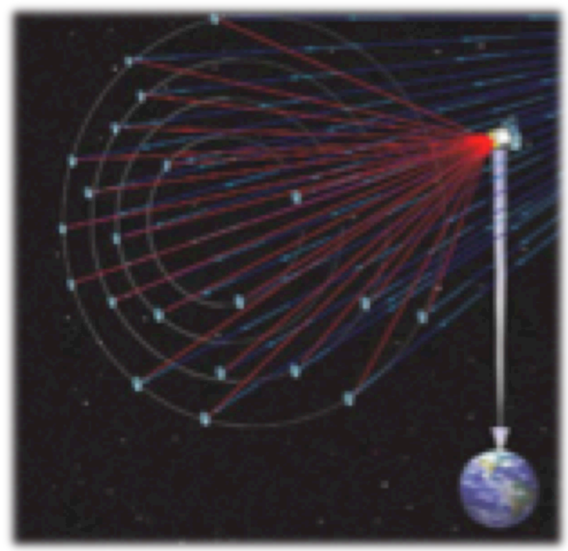
Edison Demonstration of SmallSat Networks (EDSN)

Flight Demonstration Description:
Flight demonstration of a swarm of 10, 1.5 U CubeSats simultaneously deployed into a loose swarm in LEO. Will host competitively-procured scientific instruments to demonstrate distributed, multipoint space weather measurements.

Objectives:
- Determine the utility of large swarms or constellations of small spacecraft
- Lower the unit cost and shorten the schedule of future small spacecraft
- Enable the creation of new scientific, commercial, academic, or government spacecraft applications

Project Start: Nov 2011
Project Completion: Nov 2013





Investment Strategy Development

Process

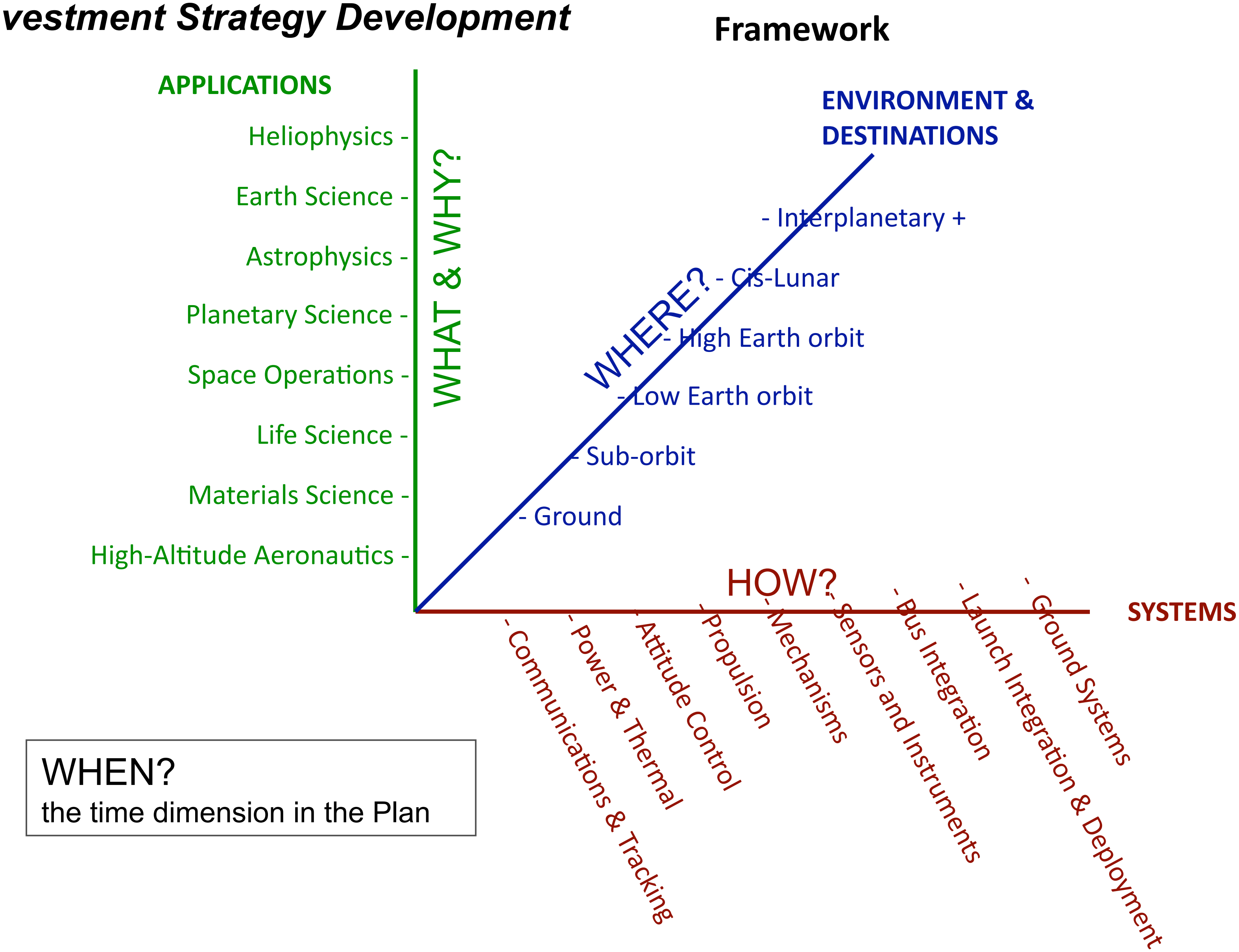
1. Assess and define the current state-of-the-art

2. Generate desired mission capabilities (be visionary)

3. Prioritize desired capabilities and the timeframe for realization

4. Derive technology development needs to support desired capabilities

Investment Strategy Development



Investment Strategy Development

Concepts

Classes of potential missions or capabilities to focus and drive investment strategy

- “Space Weather Network” – coordinated constellation of spacecraft providing distributed scientific measurements – representative of whole class of science missions
- “Made in Orbit” - spacecraft assembled from parts by crews on ISS (satellites, small space vehicles, re-entry vehicles)
- “NEO Explorer” – network of microprobes that can operate on or around an asteroid
- “Debris Remover” – spacecraft that can de-orbit or shorten orbital lifetime of inoperative satellites or debris
- “Upper Atmosphere Swarm” – coordinated group of spacecraft that can intensely probe a volume of the upper atmosphere
- “Satellite Inspector” or “EVA Assistant” – spacecraft that can maneuver around another spacecraft (in particular ISS) to inspect and/or repair or to assist an EVA astronaut or robot. A similar concept for IVA
- “Mini X-Plane” – miniature test vehicle, “dropped” from orbit for hypersonic or other entry and landing research

CONTINUED

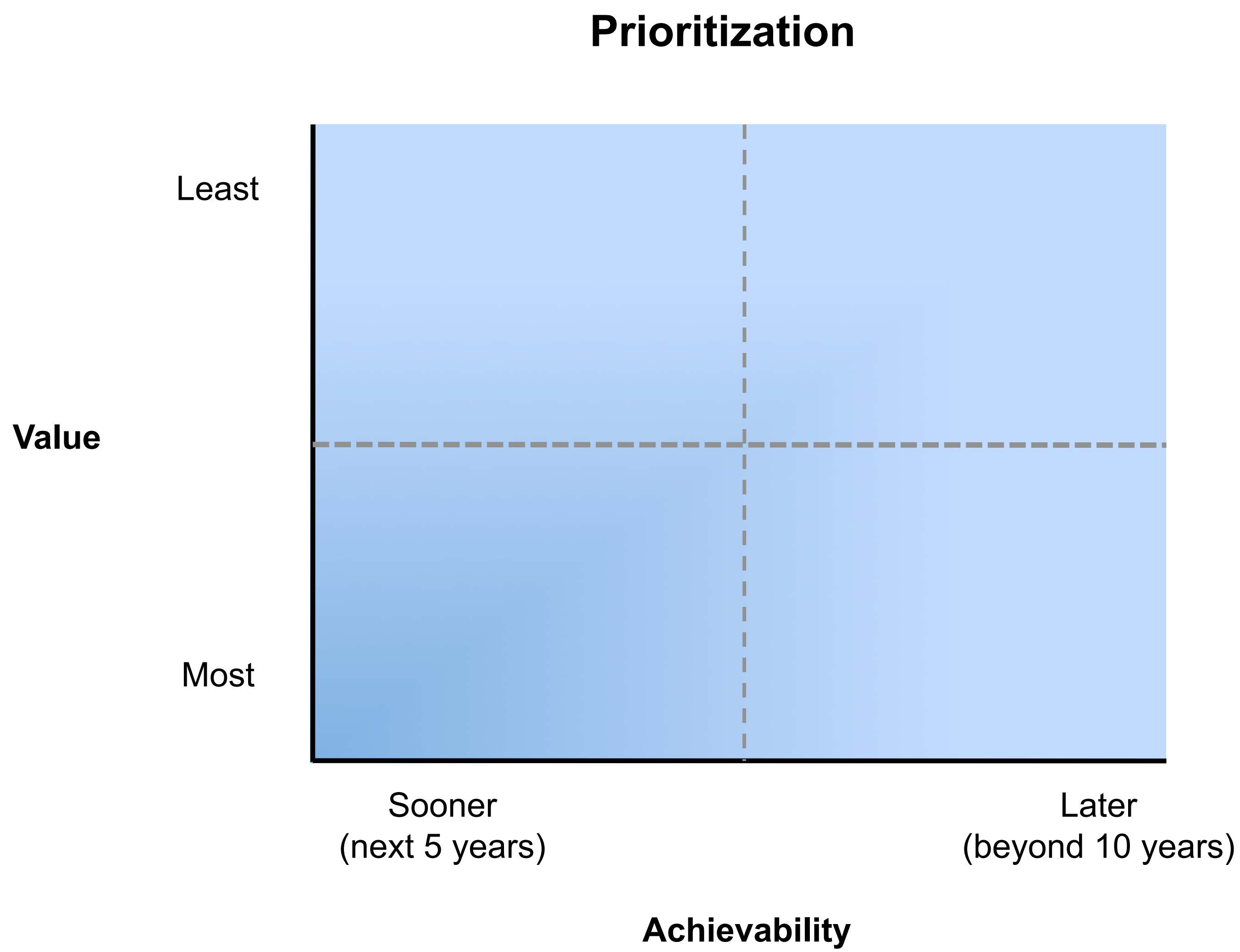
Investment Strategy Development

Concepts – CONTINUED

- “Mini Return Capsule” – spacecraft that can de-orbit and return sensitive payloads from ISS or from other satellites or space vehicles
- “Super A-Train” – a constellation of 100 or more Earth Science satellites providing continuous global data
- “Planetary Omnibus” – large planetary spacecraft composed of a simple bus and a large collection of standardized, small independent spacecraft which are released at the destination
- “Self-Assembling Satellite” – satellite assembled in orbit from components that are themselves self-sufficient smallsats
- “NEO Beacon” - a super-long-life, rad-insensitive beacon to be deployed on NEOs and comets or other spacecraft (in that case a spacecraft “black box”)
- “Solar System Internet” – not a spacecraft but a system for flexible communications links from spacecraft to the internet
- Micro-landers and Micro-rovers

Others?

Investment Strategy Development



Technology Stretch

Reaching for technology capabilities - that are enabling for small spacecraft or initially possible with small spacecraft - and might offer more general technology advancement or unanticipated science capabilities

Examples:

•Propulsion systems that minimize or eliminate toxic, corrosive, radioactive, cryogenic, explosive, or high-pressure systems or materials

•Power generation and storage systems significantly beyond the capabilities of the best batteries and PV arrays (while also minimizing hazards mentioned above)

•Radiation-*tolerant* systems – an alternative to *rad-hard electronics*

•Ultra-lightweight spacecraft – that can be built in space with materials and structural designs that could not withstand launch or even 1g

•Innovative shielding – for example, a smallsat suspended within an outer shell with no physical attachment – what science might that enable?

•Spacecraft that dissolve, or dispose of themselves in other ways, when their mission is over.

Others?

Please visit:

www.nasa.gov/smallsats

*and **Booth 28***

Small
Spacecraft
Technology